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(54) **Cathode for use in the electrolytic refining of copper**

(57) The cathode comprises a stainless steel hanger bar 11 having a flat undersurface 12 with end portions 13 adapted to rest upon supports and electrical contacts, a flat stainless steel starter sheet 14 welded by its upper edge to the undersurface 12 between the end portions 13 so as to extend perpendicularly from said undersurface, the bar 12 and at least the marginal upper portion of the sheet 14 by which it is welded to the under-surface 12 of the bar being clad (e.g. plated) with copper as represented by the stippling. At least the upright side edges of the sheet 14 carrying masking 18.

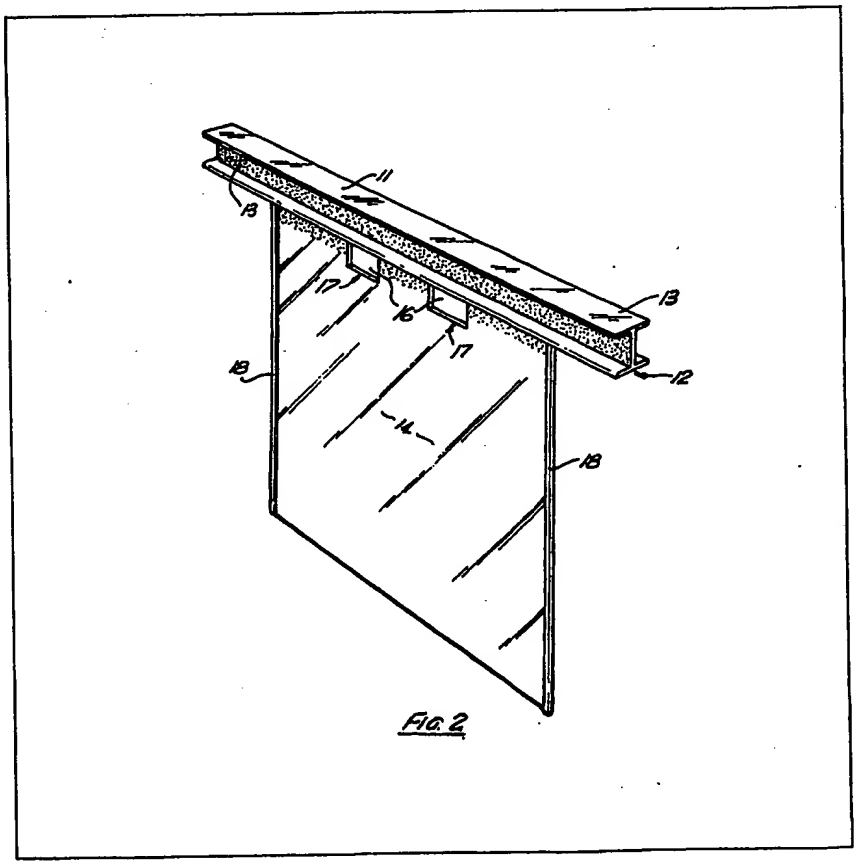

FIG 2

The drawing(s) originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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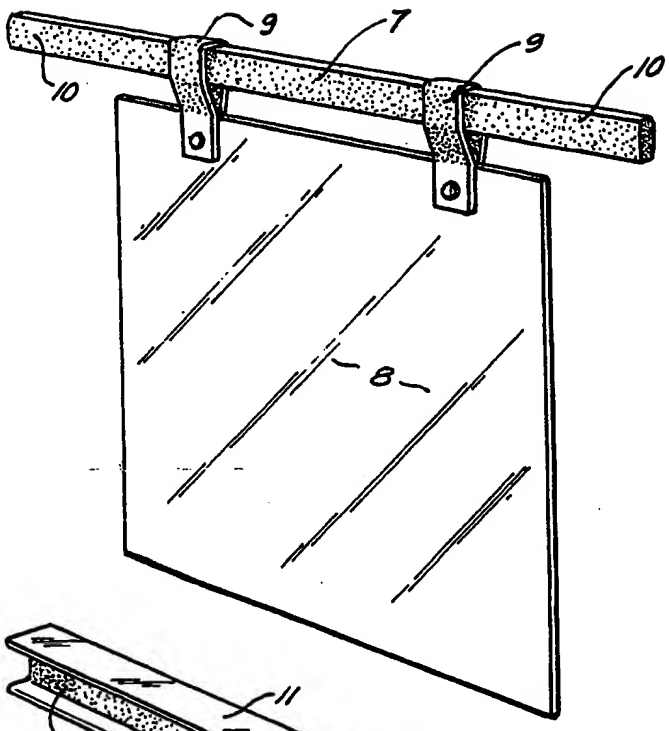

FIG. 1

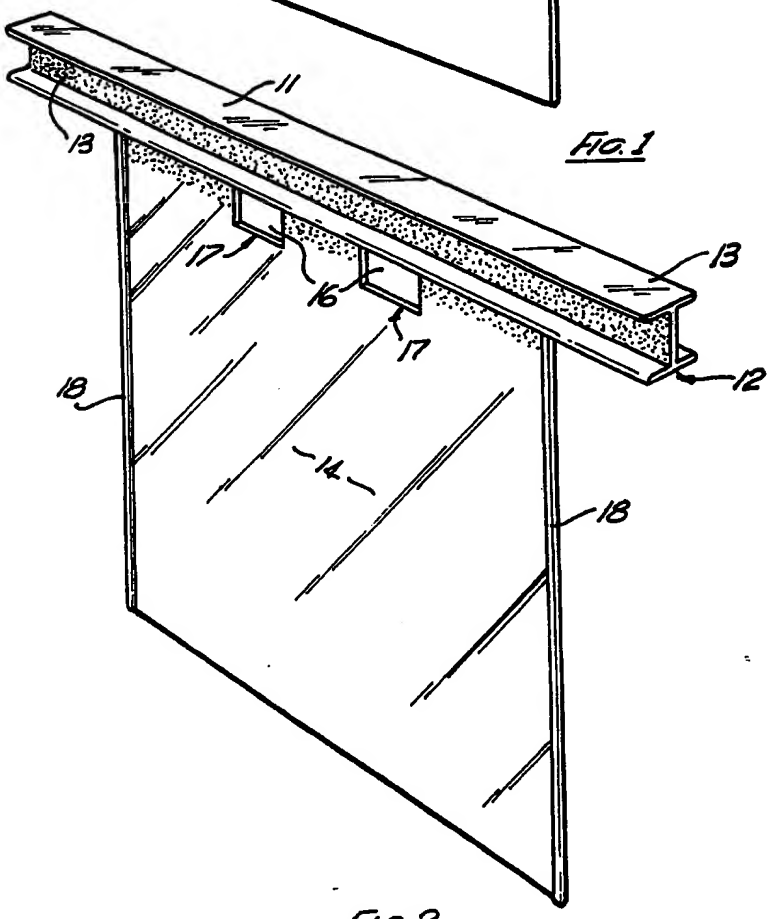

FIG. 2

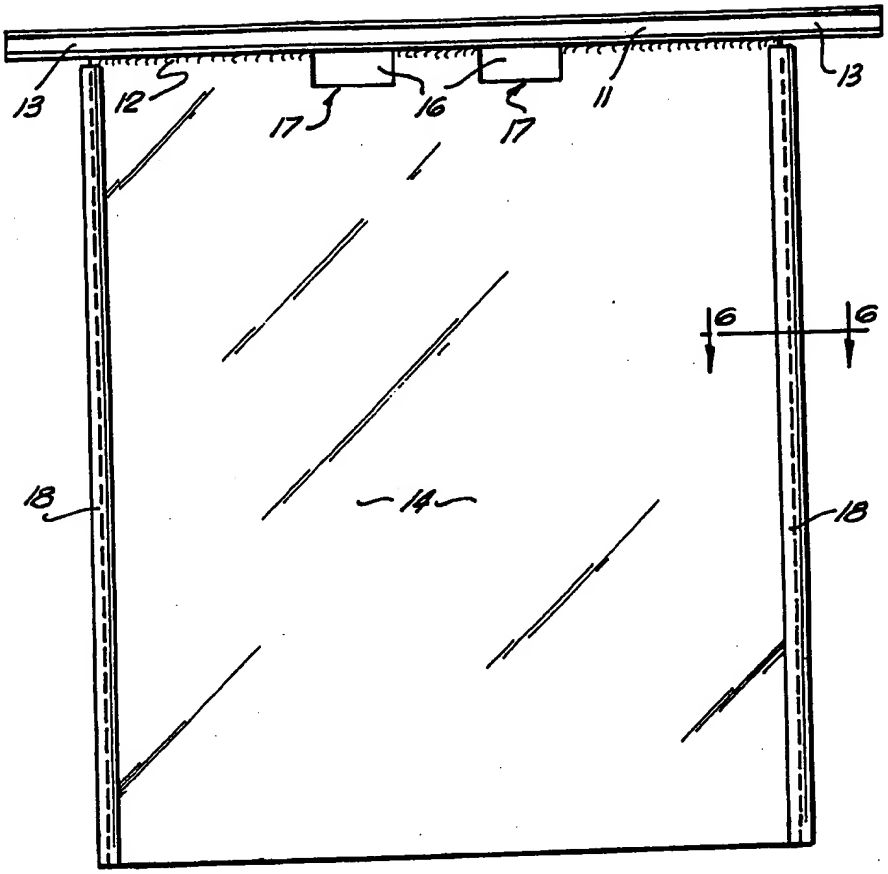

FIG. 3

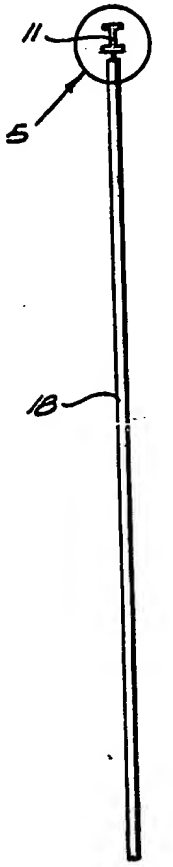

FIG. 4

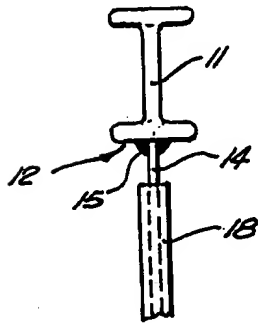

FIG. 5

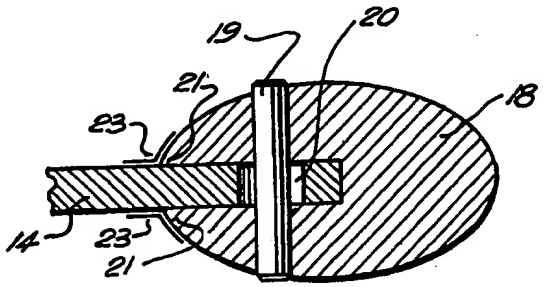

FIG. 6

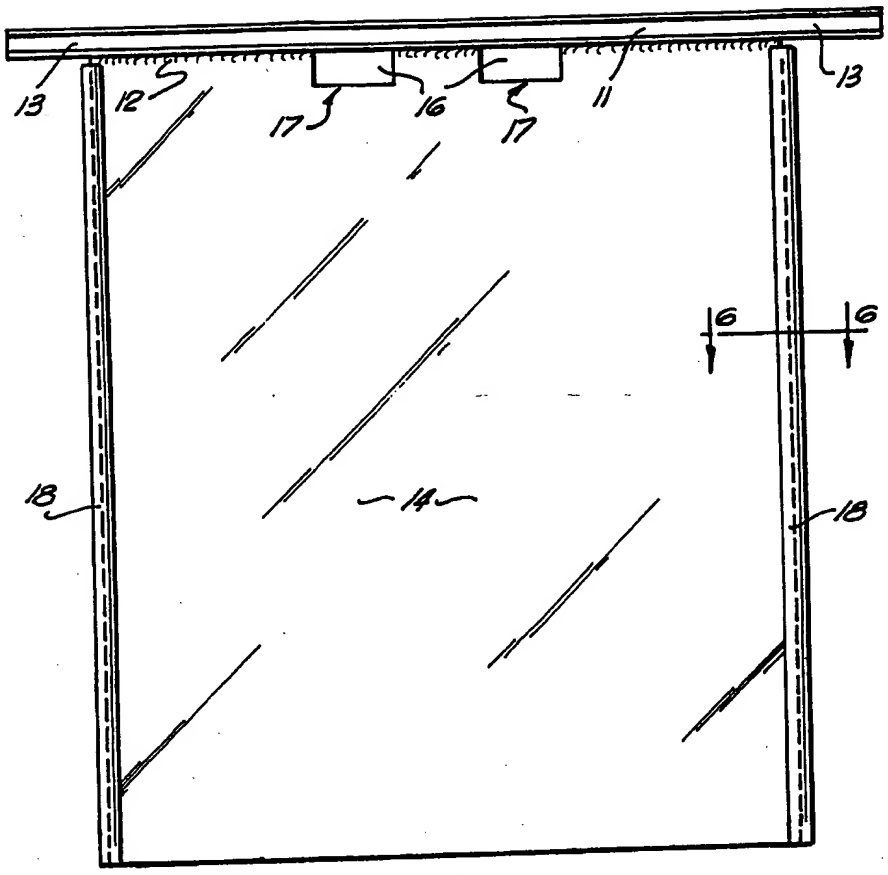

FIG. 3

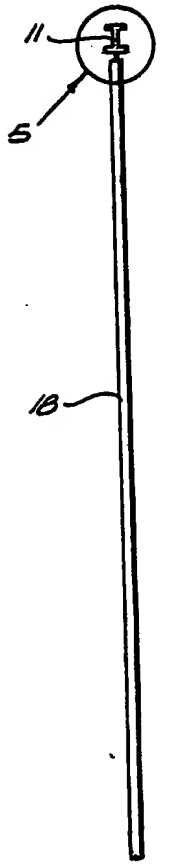

FIG. 4

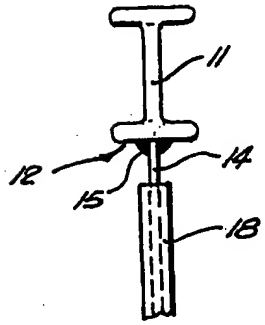

FIG. 5

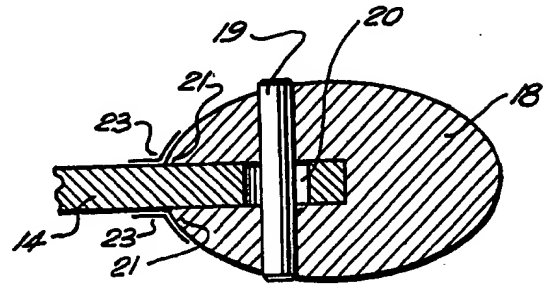

FIG. 6

The special starter sheet manufacturing operation involving additional control, higher power consumption per tonne of product, and considerable expenditure on labour can be eliminated by the use of the present invention in all cells and for a longer time growth (a week or more instead of only 24 hours) before stripping. It also provides a suitable electrode for mechanical handling and mechanical stripping of which the product is commercial refined cathode copper.

In addition the accurate dimensions of the starter blank, when coupled with accurately dimensioned anodes, provide the facility to operate at closer spacing of electrodes thereby considerably reducing power costs, and most importantly largely eliminating short circuits, thus further reducing labour costs and offering a better facility for computer monitoring of short circuits. Furthermore the more intensive operation made possible with closer spacing, and the higher current density at which the refining operation can be performed because of the elimination of short circuits, means that the plant for a given annual capacity can be housed in a smaller building, thus offering considerable savings in capital investment for that building.

The elimination of starter sheets and their requirement of special, larger area, anodes and particularly the ability to take more "pulls" from a loading of anodes all reduce the amount of "working" copper in the process at any time. As this reduction can be of the order of 20% of say 10,000 tonnes, the amount of money invested in the copper in process is considerably reduced.

The invention provides a cathode for use in the electrolyte refining of copper, comprising:

A stainless steel hanger bar having a flat undersurface with end portions adapted to rest upon supports and electrical contacts.

A flat stainless steel starter sheet welded by its upper edge to said undersurface between said end portions and so as to extend perpendicularly from said undersurface,

a copper cladding which envelops said bar and at least the marginal upper portion of said sheet by which it is welded to said undersurface, and

means to mask at least the upright side edges of said sheet.

It will be appreciated that terms used herein, such as "undersurface", "upper edge" and others implying a specific orientation for a cathode or the parts thereof, are used for descriptive convenience. Such terms are literally applicable to a cathode when in normal use suspended in an electrolytic cell.

A preferred embodiment of the invention is illustrated in Figures 2 to 6 of the drawings herewith.

Figure 2 is a perspective view of a cathode not drawn to scale as previously explained.

Figure 3 is a side elevation of the same cathode when drawn to a presently preferred scale.

Figure 4 is an end elevation projected from Figure 3.

Figure 5 repeats, on a enlarged scale, that part of Figure 4 enclosed by circle 5.

Figure 6 is a section taken on line 6-6 on a still further enlarged scale.

Referring to Figures 2 to 6, a stainless steel hanger bar 11 is preferably of RSJ or I-beam cross-sectional shape as shown. It could be of some other shape, but that shown is preferred because it is of light weight and hence economical of the steel employed, it is structurally sound and it provides a relatively large surface area for the current to be transmitted. Bar 11 has a flat undersurface 12 and end portions 13 adapted to rest on support and electrical contacts as well understood.

A flat stainless steel starter sheet 14 is welded, as indicated at 15 in Figure 5, by its upper edge to undersurface 12 so that the sheet extends perpendicularly from the undersurface 12. Sheet 14 preferably has a pair of holes 16 gapped from it prior to welding. These holes facilitate mass handling of a number of the cathodes by support rods or prongs extended through the holes.

A range of stainless steels may serve effectively as starter plates according hereto, for ease of copper stripping howeve we prefer to use that grade of stainless steel marketed as "AISI 316 ELC" and having what is known as a "2B" standard of surface finish. This steel is one having an approximate analysis of:

Carbon	0.03% by weight
Nickel	12.0% by weight
Chromium	17.0% by weight
Molybdenum	2.25% by weight

and the 2B surface finish is one intermediate bright and dull, being a silvery-grey, semi-bright surface produced by cold rolling, softening and descaling, and then final rolling lightly with polished rolls.

The indicated steel and surface finish are preferred, as experiment has shown that they provide a sufficient tenacity of attachment between the steel sheet and the copper deposited therein to prevent the copper from peeling or slumping from the steel on its own accord; yet, this tenacity is not such as to impede ready stripping of the copper from the steel sheet. Stripping may be performed by use of knife-like blades or knife-edge wedges inserted between the steel sheet and the deposited copper at the upper edge of the copper; however, using stainless steel of the kind and surface finish indicated above, our experiments have shown that effective stripping may be carried out automatically by passing the copper laden cathodes through a hammering station in which the deposited copper is smartly rapped near its upper edge from both sides, this loosens the copper upper edge and stripping is then finished by directing one or more streams of

air into the minute space between the steel and the loosened upper edge of the copper.

The stainless steel out of which the hanger bar is made may be the same as that from which the starter sheet is made. The bar may however, by of any other stainless steel provided it is one to which the sheet is weldable.

As previously mentioned herein, stainless steel is not a particularly good conductor, and use of a hanger bar made only of such steel is not a sufficient vehicle for passage of current between bus-bar and starter sheet. We have found that this can be overcome by simply cladding the hanger bar, and a top margin of the sheet welded to it, with copper. This cladding may be applied by published techniques of plating and a thickness of about 1 m.m. is preferred to provide adequate electrical conductivity and the ability to withstand corrosion and machanical drainage. It will be recalled that earlier herein the presence of an oxide film on the starter plate is regarded as desirable owing to its ability to act as a parting layer to facilitate stripping of copper from the sheet.

The width of the copper plated margin at the top of the starter sheet is not critical provided it stops short of the top surface of the electrolyte. Obviously, deposit of copper on the plating area must not occur. Similarly, the plating area on which refined copper will be deposited in the operating process must not extend onto the lower edges 17 defining holes 16. It follows, that the copper plating may conveniently stop short of the edges 17 provided it covers the (preferably sand-blasted) weld metal at 15.

It will be apparent that ease of copper stripping requires effective masking of the starter sheet edges so that the deposit of copper will not be continuous about those edges. This is particularly the case with the upright side edges of the plate. The bottom edge is less in need of maskng and in the case of that edge masking could be omitted; however, to improve assurance of clean stripping we prefer to mask the bottom edge merely by giving it a hot dip, to a depth of about 10.00 mm, of a high melting point resilient wax, or other masking material.

With regard to masking of the side edges of the starter sheet the present invention displays a further important advantage over the titanium sheets referred to previously herein.

In titanium starter sheets, owing to the relatively high conductivity of that metal, there is a proneness for creep of deposit copper particles under the masking strip material. Once that happens copper nodules continue to grow under the mask strip (usually of plastics material) thus tending to lift the strip and so defeat the reason for masking and also create the need for re-masking before further use.

With stainless steel starter sheets, the relatively poor conductivity discourages copper growth under the masking means and such growth is thereby reduced to such a degree as to become inconsequential.

Notwithstanding this, the desirability of effective masking of at least the side edges of the starter sheet remains; and, for preference, the form of masking which we employ is as shown best in Figure 6.

Referring mainly to that figure, the masking means comprise a longitudinally slotted plastics beading 18 held on to the sheet 14 by plastics pins 19. These pins extend through holes 20 formed in plate 14.

The beading 18 and the pins 19 are preferably made of the same plastics material, and one suitable material is a high quality, heat and impact resistant plastic such as that known as CYCOLOY 800. This being a polymeric alloy of acrylonitrile-butadiene-styrene, (ABS) and polycarbonate as described in U. S. patent 3,130,177.

The beading 18 and the pins 19 are secured together by use of a suitable bonding material such as a 30% solution of Cycoloy 800 in methylene chloride.

Such a bonding material sets to an elastic condition and in addition to acting as a bonding agent it serves a useful purpose in the following manner.

During the experimentation which led up to the present invention it was found that on some occasions there was a tendency for the applied beadings to slightly bulge between the pin fastenings. This was, of course, objectionable and it was considered to be due to difference in expansion rates between the steel and the beading. This situation was remedied by making the holes 20 oversized as shown in Figure 6. In applying the beadings and the pins the holes 20 are filled by the solvent material which sets to an elastic condition so to act as expansion joints permitting sufficient longitudinal movement of the beading relative to the starter sheet as will compensate for the expansion rate difference.

The beadings 18 are preferably first formed by extrusion, or injection moulding, and in this action it is desirable for the points 21 defining the aperture of slot 22 to be placed closer to each other than is shown in Figure 6. Thus, when the beading is applied to the sheet, the sides of the slot 22 have an inbuilt resilient loading tending to press them firmly in contact with the sheet.

As a further precaution the points 21 are preferably sealed relative to the starter sheet by the application of wax or other material sealing strips as indicated at 23.

CLAIMS

1. A cathode for use in the electrolytic refining of copper, comprising:

a stainless steel hanger bar having a flat undersurface with end portions adapted to rest upon supports and electrical contacts,

a flat stainless steel starter sheet welded by its upper edge to said undersurface between said end portions and so as to extend perpendicularly from said undersurface,

a copper cladding which envelopes said bar and at least the marginal upper portion of said sheet by which

it is welded to said undersurface, and
means to mask at least the upright side edges of said sheet.

2. A cathode according to claim 1 wherein said hanger bar is of I-beam cross-sectional shape.

3. A cathode according to claim 1 or claim 2 wherein said starter sheet has lifting holes formed in it as gaps in that edge of the sheet by which the sheet is welded to said hanger bar.

4. A cathode according to any one of the preceding claims wherein said starter sheet is formed of stainless steel containing:

Carbon	0.03% by weight
Nickel	12.0% by weight
Chromium	17.0% by weight
Molybdenum	2.25% by weight

5. A cathode according to any one of the preceding claims wherein said copper cladding is formed by platig.

6. A cathode according to any one of the preceding claims wherein said masking means comprise plastics beadings each having a longitudinal slot by which the beading embraces the sheet, and a plurality of plastics pins extending through holes formed in said sheet and having those portions of them disposed on either side of said slot bonded within said beading.

7. A cathode according to claim 6 wherein said beading is so formed by extrusion and said pins are so applied thereto that the sides of said slot are resiliently loaded to bear firmly against a starter sheet portion placed therebetween.

8. A cathode according to claim 6 or claim 7 wherein the holes in said sheet to receive said pins are over-sized relative to said pins and the open space thus created is filled with elastic solvent material so that each of the joints established by said pins constitutes an expansion joint.

9. A cathode according to any one of claims 6 to 8 wherein said masking means include wax strips by which the interior of said slot is sealed in relation to that portion of the starter sheet inserted in said slot.

10. A cathode according to any one of the preceding claims wherein the lower edge of said sheet is masked by a coating of a hight-melting point, resilient wax applied thereto.

11. A cathode for use in the electrolytic refining of copper substantially as herein described with reference to Figures 2 to 6 of the drawings herewith.

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